NOTES ON ANCIENT BRITISH MONUMENTS.[1]

VI.—DOLMENS.

IN some previous notes I have given an account of some measurements of the so-called "cromlechs" of Cornwall. In referring to this subject in a more

FIG. 18.—Devil's Den, Avebury, looking towards November sunrise.

general manner, it will be well, I think, *pour préciser les idées,* to refer to the word itself. In English works on archæology it is used as a variant for dolmens, chambered barrows, chambered cairns, and kistvaens, while in France it is applied to the more or less irregular circles and groups of stones associated with avenues; and there the equivalents of the Cornish "cromlechs," which exist in great numbers, are invariably called dolmens.

It is convenient, therefore, to use the word dolmen when such structures are considered separately from the circles.

With regard to the examples available for measurement in Cornwall, the important, and indeed striking, conclusion was arrived at that almost all those given by Lukis were erected so that the sunrises at the May-year or solstitial festivals could be plies to other localities, and referred to other similar structures in S. Wales which gave the same results.

I now propose to go further afield, with the view of inquiring whether this law applies to other localities, and I will begin with one I have myself measured, the Devil's Den at Avebury.

The conditions at Avebury are as follows:—Lat. N. 51° 25′. Magnetic variation, 16° 40′ W., 1906.

[1] Continued from p. 371.

Theoretical value of May-year azimuths.

	May True	May Magnetic	November True	November Magnetic
1½° hill: refraction and semi-diameter	N. 64° 26′ ...	81° 6′ ...	S. 61° 50′ ...	134° 50′

My wife and I visited the Devil's Den, in company with Mr. R. H. Caird, in July, 1906, and again in August, 1907. The compass bearing was N. 134° E. looking eastward through the aperture formed by the three stones, and the height of the horizon in this direction was 1° 25′, thus agreeing with the value of the November sunrise given in the table.

Here then, as in Cornwall, the November and February sunrises, when the sun has a S. declination of 16° 20′, are in question.

It is well known that two of the most famous long barrows in England with their included dolmens are close to Avebury; one of them, the "West Kennet Long Barrow," is described in Smith's "British and Roman Antiquities of N. Wiltshire," p. 154. I condense his reference:—

"The 'West Kennet Long Barrow,' indeed, is one of the most notorious, as well as one of the largest of the Long barrows in the kingdom; and although it is much cut about, with a waggon-track passing over the centre of it, a confusion of large sarsens tumbled together at the east end, and several big trees occupying its sides,

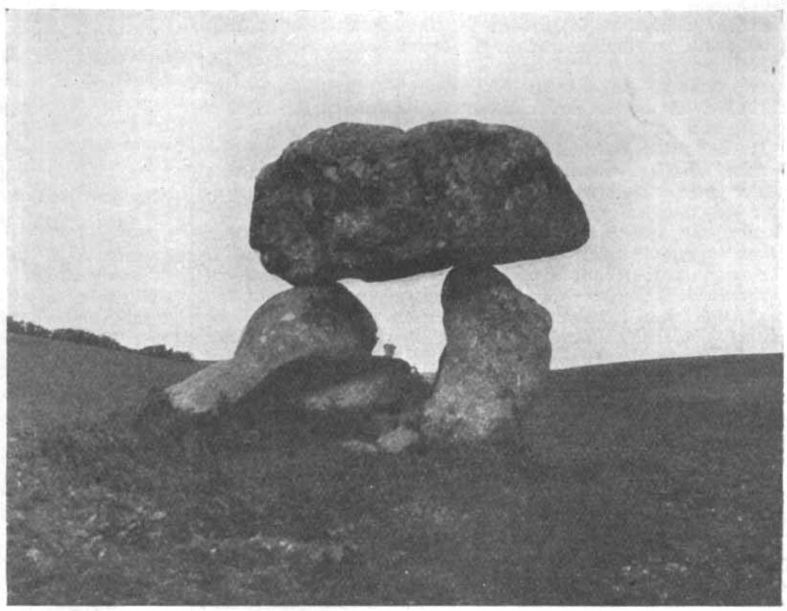

FIG. 19.—Devil's Den, looking towards May sunset.

it is still of imposing appearance. Let us first see what our old Wiltshire antiquaries thought of it, and then what it proved to be, when opened by Dr. Thurnam. Aubrey gives but a brief and very inaccurate description: 'On the brow of the hill, south

from West Kynnet, is this monument, but without any name: It is about four perches long, but at the end only rude grey-wether stones tumbled together. The barrow is about half a yard high.' "[1]

Stukeley says of it[2]: "The other Long barrows are much exceeded by South Long Barrow, near Silbury Hill, south of it, and upon the bank of the Kennet. It stands east and west, *pointing to the dragon's head on Overton Hill.* A very operose congeries of huge stones upon the east end and upon part of its back or ridge, pil'd one upon another, with no little labour. . . . The whole tumulus is an excessively large mound of earth 180 cubits long, ridg'd up like a house."

Sir R. Hoare's account of it[3] is as follows:—"There are several stupendous Long barrows in the neighbourhood of Abury: one of the most remarkable has been recorded by Stukeley as situated south of Silbury Hill. It extended in length 344 feet: it rises, as usual, towards the east end, where several stones appear above ground: and here, if uncovered, we should probably find the interment, and perhaps a subterraneous kistvaen."

Dean Merewether states[4]:—"At the east end were lying, in a dislodged condition, at least thirty sarsen stones, in which might clearly be traced the chamber formed by the side uprights and large transom stones, and the similar but lower and smaller passage leading to it: and below, round the base of the east end, were to be seen the portion of the circle or semi-circle of stones bounding it."

I have given this somewhat long account because it shows that all information relating to orientation is omitted from it; it is generally, indeed, neglected by modern archæologists. Even Stukeley himself, though he was thoroughly acquainted with magnetic variation and at times used a theodolite, is caught napping in the case of this barrow. Fortunately, however, the apparently useless statement that the barrow points to the dragon's head on Overton Hill helps us, as this was a circle the site of which is known, though the stones have disappeared. This bearing (true) is N. 64° E. as determined from the 6-inch Ordnance map.

Here again, then, we deal with the May year and the May and August sunrises, still another argument in favour of Avebury and its region being connected with the May year.

I may next refer to some cromlechs near Dublin (lat. 53° 20′ N.), which were described by Prof. J. P. O'Reilly.[5] I give the results of his stated amplitudes in tabular form:—

Cromlech	Value given	Azimuth	Hill	Declination
Glen Druid...	E. 24° 30′ N. ...	N. 65° 30′ E. ...	½ (assumed)	... 14° 20′ N.
Howth...	... E. 27 0 N. ...	N. 63 0 E. ...	½ (assumed)	... 15 44 N.
Mount Venus	E. 23 28 N. ...	N. 66 32 E. ...	0	... 13 5 N.
Shankill ...	,, ...	,, ...	,, ...	,,
Larch Hill ...	,, ...	,, ...	,, ...	,,

It will be seen that here again we are in all probability dealing with the May and August sunrises, when the sun has a declination of 16° 20′ N.

It is to be regretted that in Borlase's fine book on the dolmens of Ireland, the lack of all accurate statement touching the lie of the monuments renders its thousand pages and hundreds of illustrations quite useless for my purposes.

After what I have suggested as to the probable use of dolmens, namely, that they were useful among other things as look-out places, it is not to be expected that only the rise of the sun would be found provided for. They should follow the precedent of the avenues, and be presented to star as well as to sun rise.

In two instances known to me the information is complete enough to enable a stellar use to be traced.

The first is at the Hurlers. Full details have been already given in my "Stonehenge."

The second is at Callernish (Turnsachan, lat. 58° 12′ N.). A good description of the stone monuments there, which include a circle, avenue and cromlech, is given in Anderson's "Scotland in Pagan Times" ("The Bronze and Stone Ages," p. 119).

They were, fortunately, also carefully surveyed by Sir Henry James.

We learn from Anderson that:—

"In 1858, Sir James Matheson caused the peat which had grown on the site of this monument to be removed. The average depth of the peat from the surface to a rough causewayed basement in which the stones were imbedded was 5 feet. In the process of the removal of this accumulation, the workmen uncovered the remains of a circular cairn, occupying the space between the centre stone and the east side of the circle. In the centre of the cairn was a chamber with regularly built internal walls, and a passage leading from it to the outside of the cairn, the opening being placed between two of the stones of the circle. The chamber was divided into two compartments by slabs placed across the floor, leaving an opening between their edges a little less than 2 feet wide. Beyond these slabs the inner compartment was formed of dry-walling in the sides, and a long slab set on edge at the back. The passage was about 6 feet in length, and 2 feet wide, entering the chamber between two slabs set on end facing the two on each side of the entrance to the inner compartment. The first compartment was 6 feet 9 inches from side to side, and 4 feet 3 inches from front to back, the second, 4 feet 4 inches from side to side, and 2 feet 1 inch from front to back on the floor, widening upwards in consequence of a slight inclination of the slab at the back. With the exception of a single stone, which was supposed to have been a lintel, there was no appearance of a roof, and there is nothing on the record of the excavation to show whether the roof of the chamber had fallen in, or whether it had been removed. It is not even stated what was the height to which the side-walls were found standing. But it is obvious at a glance that here we have a very peculiar construction,—a cairn containing a chamber divided into compartments, and furnished with a passage opening to the outside of the cairn."

From Sir H. James's plan we get the data necessary for orientation purposes. They are as follows for the sight-line from the chamber:—

Az.	Horizon (1″ map)	Decl.	Star	Date
N. 74° 30′ E. ...	1° 18′ ...	8° 54′ N. ...	Pleiades ...	1330 B.C.

In 1330 B.C. and lat. 58° 15′ N. the Pleiades warned the May sun by about 1¼ hours; in 1901 B.C. the warning was of about 1 hour duration. Thus, taking into account the high latitude, with the consequently extended dawn, the Pleiades warning was more effective in 1300 B.C. than it would have been at the earlier epoch, at which, as I have previously shown, the stones of the long avenue were probably erected.

Prof. Morrow has recently sent me measures of the side walls of the curious structure on the N.E.

[1] From MS. in the Bodleian Library at Oxford, quoted in "Archæologia," vol xxxviii., p 407.
[2] "Abury Described," p. 46.
[3] "Ancient Wilts, North," p. 96.
[4] Proceedings of Archæological Institute, Salisbury volume, pp. 97, 98.
[5] Proc. R.I.A., iv., pp. 589–605 (1896–8).

side of the circle of Keswick. These are doubtless to be considered in relation to the direction of the chambered cairn at Callernish. The rising of the Pleiades seems to have been in question.

Still another stellar dolmen I measured in S. Wales has already been referred to.

NORMAN LOCKYER.

EXPERIMENTS ON SCREW PROPELLERS.[1]

THE screw-propeller was practically applied to steamships by John Ericsson and Francis Petit Smith about seventy years ago. It speedily became a formidable rival to the paddle-wheel. Long ago it entirely superseded the latter for ocean navigation, and in more recent years it has to a large extent taken the place of the paddle, even in river steamers of the shallowest draught. Accumulated experience over this long period has proved of great advantage, and has enabled naval architects and marine engineers to meet new conditions in ships of much larger dimensions and higher speed; but notwithstanding this wealth of experience—largely based upon "progressive trials" of steamships and the analysis of the results—it is still true that we are on the threshold of exact knowledge in regard to the principles underlying the efficiency of screw-propellers.

Even in recent years, when the limits of experience have had to be surpassed, there have been many proofs of imperfect knowledge. On the whole, it is true that success has been achieved, but not infrequently as the result of numerous and sometimes costly experiments on propellers of different forms. Perhaps the most striking example of this general truth is to be found in the case of torpedo vessels and motor boats, driven at extraordinarily high speeds in proportion to their dimensions; it is also true that, in vessels of large size and of less speed in proportion to their dimensions, remarkable results have been obtained by a simple change of propellers. For instance, the *Drake* class of cruiser in the Royal Navy, which are the fastest cruisers afloat, had a guaranteed speed of twenty-three knots on an eight hours' trial. The guarantee was slightly exceeded in the first trials, but there was evidence that the propellers became relatively inefficient as the highest speeds were approached, and that the blade-area was insufficient. New propeller blades were made with greater blade area, and with these the ship was driven at a speed exceeding twenty-four knots, representing a gain of about 25 per cent. in efficiency. Obviously, incidents of this nature point to the possibility of very large economies if our knowledge of screw-propeller action and efficiency could be made more definite as well as more extensive. Trials in actual ships, especially those of large size, are necessarily costly, and are often impossible to make because the vessels are required on service. Hence, at a very early date, attempts were made to introduce a system of experiments with model screw-propellers, and from these useful information was obtained. It was left for the late Mr. William Froude to perfect the method of experiment in connection with his well-known system of "tank" experiments on models of varying ship forms; and his son, Mr. R. E. Froude, superintendent of the Admiralty experimental tank at Haslar, has carried on and developed the investigation so far as the pressure of other and more urgent experiments connected with the construction of ships for the Royal Navy has permitted.

The model propellers used by Prof. Durand were forty-nine in number, of 12 inches diameter, with bosses of uniform diameter (2·4 inches); all the models had four blades, and all the blades were elliptical in shape. Blade-areas and pitch-ratios were varied over wide limits, going beyond the range of variation occurring in actual practice. For example, the pitch-ratios tried extended up to 2·1 from 0·9 by differences of 0·2, and the blade-areas were carried down to unusually small proportions of the disc area. Great care was taken to shape the model screws truly and to measure the pitch accurately. For each propeller there was a determination of the power absorbed and the thrust developed for a given number of revolutions per minute, and a corresponding record of the speed of advance in undisturbed water. Practically uniform motion was ensured, and accurate measurements were made of time, distance and force. From these experimental data the actual and comparative efficiencies of the model-screws were ascertained, and the percentages of "slip" could be estimated. The facts are tabulated and graphically illustrated in the memoir. They require and deserve detailed study. In this brief notice it is not possible even to mention the most striking features. Prof. Durand briefly summarises his conclusions in regard to the character of the efficiency-curves of the different model screws, and supplements this section by a description of the method he recommends for applying experimental results to propeller design for actual ships.

One cannot peruse this memoir without regretting that, as yet, no British university, or public institution primarily devoted to scientific work, possesses an experimental tank such as is attached to Cornell University, the University of Michigan, and to the Technical High School at Charlottenburg. Its value for purposes of instruction is great; but its importance as a means of research can hardly be over-estimated. When tanks are closely associated with the detail-work incidental to the design of actual ships, the opportunities for research are less, and the interruptions of research-work more numerous and serious when undertaken in the intervals of ordinary employment. In other words, research has to give way to urgent demands connected with ship-designs, and the special apparatus required for research has to be removed or dismantled at short intervals. This has been the experience at the Admiralty tank, and at the two tanks attached to the shipbuilding yards at Dumbarton and Clydebank. A great need exists, therefore, in this the greatest shipbuilding and ship-owning country in the world, for an experimental tank in which research work on ship-forms and propellers can be undertaken systematically and uninterruptedly. This need has been recognised for a long time. The Institution of Naval Architects has made efforts to interest ship-owners and ship-builders in the establishment of such a tank at the National Physical Laboratory. Considerable support has been obtained from ship-builders and from a few ship-owners, but hitherto it has not been possible to secure the whole amount needed for the construction and equipment of the tank, estimated at 15,000*l*., or for its maintenance, estimated at 1500*l*. a year. This failure is greatly to be regretted, and is not creditable to the community interested in shipping. It is certain that the investigations made at such an establishment would secure large economies and enable great advances to be made in the construction and propulsion of ships. In connection with screw-propellers alone there is a great opportunity for economies in coal-consumption, the benefits of which would be secured by ship-owners, and the amount of which in a single year's operations of our immense mercantile marine would far exceed the cost of the research-tank. Seeing that the United States and Germany already have a

[1] "Researches on the Performance of the Screw Propeller." By Prof. W. F. Durand. Pp. 61. (Washington: Carnegie Institution, 1907.)